WASON'S SELECTION TASK:

CONTENT EFFECT, INSTRUCTION EFFECT OR BOTH?*

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INTRODUCTION

The study of content effects on reasoning has been one of the principal lines of investigation in conditional inference. One of the most widely used paradigms for studying the importance of factors related to the role of pragmatic knowledge, which subjects have with regard to the content of arguments, is a metainference task: Wason's selection task (Wason, 1966, 1968).

In the 1970's various investigations revealed a facilitating effect in executing the task, when thematic content was used instead of the original abstract version, or formal content, with letters and numbers (Wason and Shapiro, 1971; Johnson-Laird, Legrenzi and Sonino Legrenzi, 1972; Bracewell and Hidi, 1974; Gilhooly and Falconer, 1974; Van Duyne, 1974). However, not all of these investigations were able to duplicate these facilitating effects, from Manktelow and Evan's (1979) now classic study (see Evans, 1982, 1989; Wason 1983, and Newstead and Evans 1995, for revisions).

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Despite this, certain consensus has existed since the mid-1980's in literature considering that daily reasoning is "*content-dependent: dependent, that is, on content which evokes relevant knowledge from the memory"* (Manktelow and Over, 1990, p. 111). However, there is no consensus between the different theoretical viewpoints on how to explain the influence of factors related to the content and context of reasoning.

The most serious criticism about the syntactic theories of formal rules are precisely directed at their weakness in being able to explain these factors in subjects' reasoning (Evans, 1991; Johnson-Laird and Byrne, 1991; Evans, Newstead and Byrne, 1993).

In the 1980's theoretical points of view appeared that did not suggest systems of rules of a general nature in reasoning, but instead a specific group of rules of authority, sensitive to the context and that could be applied to particular aspects of daily life. Cheng and Holyoak's theory of pragmatic schemas (1985, 1989) and the theory of social contract (Cosmides, 1985, 1989) are included among these. From here on two debates appear in literature: a) pragmatic schemas vs. presentation effects of the task, and b) pragmatic schemas vs. social contract. We will concentrate on the first of these, the most relevant in this context

The theory of schemas proposes that certain effects of content facilitation in Wason's selection task are due to the use of pragmatic schemas or rules that are sensitive to the context. Some of these schemas refer to causal situations, and other to deontic schemas (permissions, obligations), that may be summed up in 4 productive rules (P_1-P_4 and O_1-O_4) (Holyoak and Cheng, 1995).

In the light of these suggestions, Jackson and Griggs (1990) argued that the facilitating effect in the selection task was due to the combination of two presentation factors in the task: 1) the use of explicit denials in presenting the *not-p*, *not-q*, and 2) the presence of a context which facilitated checking violation of the rule. The results of their investigations, where no facilitation effects were registered when there were no explicit negatives, as well as those of other experiments (Griggs and Jackson, 1990), where an improvement in the performance of the selection task was registered with abstract tasks and violation instructions, corroborate their proposals. They explained both results in terms of the heuristic-analytic process theory (Evans, 1984, 1989) in such a way that the violation instruction provoked a focusing of attention on those cards that composed the correct answer.

Girotto, Mazzoco and Cherubini (1992) carried out a series of experiments of abstract content, manipulating the presence/absence of explicit denials in the cards. The presence of negatives was not necessary for the facilitating effect to be produced. For these authors, it would not be an operation of a heuristic of linguistic relevance, but instead an analytic decision, related to pragmatic relevance. They concluded that their results could be explained by using pragmatic schemas.

Theories also exist which propose that reasoning does not rely on rules. In this respect Johnson-Laird put forward a semantic focus of reasoning: the Theory of Mental Models (Johnson-Laird, 1983; Johnson-Laird and Byrne, 1991). Likewise, Jonathan Evans proposed the Theory of Heuristic/Analytic processes, where the existence of a preconscious selection of certain characteristics of the task is defended, before analytical reasoning is produced (Evans, 1984, 1989).

More concretely, Evans (1995) points out that it is necessary to describe the effects of the content that may or may not facilitate its correct performance, based on selection elements of a linguistic and pragmatic nature. In the same way, we studied in this experiment not only the nature of the content but also the influence that other variables may exert on subjects' reasoning, related to their experience and previous knowledge, the type of instructions they receive, the scenario about which they are reasoning, the inclusion in the rule of deontic terms, and the use of explicit denials.

The objectives of this experiment were: 1) To study in greater depth the role of content on subjects' reasoning in Wason's Selection Task, 2) analyse the influence of the availability of the scenario from which the subjects would have to contemplate the conclusions that were produced, 3) to check if the experimental instructions received by the subjects have an influence on their ability to reason in the four card task, and how much this possible influence is modified in relation to the content and/or scenario which they are reasoning, and 4) analyse the possible influence of variables of a linguistic character, such as the introduction of explicit denials and the use of deontic terms in the conditional rule.

In order to reach these objectives, we gave the subjects, in the framework of accessible or non-available scenarios, three different versions of Wason's selection task: a formal or abstract version, and two thematic versions (Thematic-1: permission; Thematic-2: obligation). In some cases the subjects first solved the abstract version and then the concrete tasks, and in other cases the thematic versions were those that were first presented. In order to solve each task, the subjects had to select the card or cards that they should turn over, either to check if the rule was true or to

find out if this had been violated.

Our **empirical expectations** were the following:

1. We do not identify with syntactic suggestions that have been taken up by defenders of natural logic and formal systems of rules. On the contrary, we would situate ourselves closer to theoretical suggestions that defend not only the importance of the content, but also of other semantic, contextual and pragmatic variables of human reasoning. We therefore hope to obtain significant interactive effects between the content and other variables, of those types previously mentioned.

2. One would expect a facilitating effect of the violation instructions in thematic versions of the task from the results of other studies, where the influence of the type of instructions that subjects receive on their reasoning strategies was analysed (Griggs, 1984; Valentine, 1985; Chrostowski & Griggs, 1985; Yachanin, 1986; Griggs, 1989, among others). However, we also hope that there is a facilitating effect brought about by the instructions in the abstract version of the test. In line with previous empirical results, (Yachanin, 1983, experiment 1; Griggs and Jackson, 1990; Valiña and colleagues, 1995, among others) we believe that those subjects who are reasoning about the formal version and receive violation instructions will receive very high logical indices, and, definitively, a higher number of successes, when compared to those subjects who, reasoning about the same version of the task, receive instructions for checking the truth or falseness of the rule.

3. If, as Evans (1984, 1989) put forward in his "theory of the double heuristic-analytic process", there is a previous phase to analytic reasoning in subjects who activate heuristic strategies to select relevant information,

then one may expect that when offered the possibility of activating certain heuristics, and more concretely, when they reason in available contexts, then they will present a different type of performance to when they do so in non-available contexts.

However, as the previously mentioned author commented, availabylity is a necessary condition, although not enough for heuristic selection of relevant cues in the task. Therefore, we expected that availability would, in turn, be modulated by other factors, such as the nature of the content or the type of instructions which are received (Pollard and Evans, 1987; Evans, 1995). We expected higher levels of errors when the subjects consider non-available contexts with the abstract version of the task, or when they reason about this type of context and also receive instructions on checking the rule.

4. As with the results of previous empirical results, such as those of Reich and Ruth (1982), Griggs & Cox (1983), Evans (1992; 1993; 1995) and Oaksford & Stenning (1992), among others, we consider that in the thematic versions of the task its relevance may be fundamentally determined by pragmatic, more than linguistic, types of clues. Thus, unlike Manktelow and Evan's results (1979), we expected lower indices of matching when the subjects reason about realistic contents than when they did so with the abstract version of the task.

EXPERIMENT

METHOD

Subjects

190 students at college level (113 females and 77 males; mean age 16 years 7 months), in Santiago de Compostela (Spain) volunteered to participate in this experiment . They had no previous experience of this task, nor any training in logic.

Design

A 2 x 2 x 2 x 3 factorial design with repeated measures on the last factor was used. The four factors were: availability of scenario (available or not available) x instructions (true/false version vs. violation version) x presentation order (Abstract-Thematic vs. Thematic-Abstract) x problem content (Abstract, with letters and numbers; Thematic-1, a rule expressing a law, equivalent to permission, and Thematic-2, a rule expressing a traffic regulation, equivalent to an obligation.)

Frequencies of selection combinations for the three problems, Logic Index and Matching Index (Pollard and Evans, 1987) were used.

Materials

Eight test booklets were made, each containing an instruction page and three different selection tasks (Wason, 1966, 1968), presented on separate pages. In the middle of the booklets, the subjects were asked to imagine themselves as a person with a familiar or available profession for them (for example, "*Imagine you are a lawyer"*). The selection of available

or non-available professions was carried out, based on previous investigations (Valiña, 1985, 1988; Valiña and De Vega, 1988).

The instructions for carrying out the task were those previously used by Chrostowski and Griggs (1985), Yachanin (1986), and Valiña and colleagues (1995). Half of the subjects received verifying instructions of the rule, and the other half violation instructions.

In the condition of **verification/falsification** of the rule, the instructions were the following:

"*Your task consists of selecting cards, and only those that must be turned over to decide if the rule is true or false (select those cards which you consider necessary to turn over to check if the person carrying out the experiment has lied or not in relation to the composition of the rule)".*

The violation instructions were:

"*Your task consists of selecting only those cards that must be turned over in order to decide if the rule is being violated or not".*

Each subject received three rules, with the following types of content: abstract, thematic-1 (permission), and thematic-2 (obligation). The instructions in each condition were:

a) Abstract: "*If a Wasit card has an A on one side, then it must have a 3 on the other".* The four cards presented to the subject were "A", "K", "3" and "7".

b) Thematic-1: "*If person is more than 18 years old, then he has the right to vote".* Four cards had previously appeared, which said "*20 years old", "16 years old", "you have the right to vote"* and *"you do not have the right to vote".* In this rule a law was expressed; therefore it is similar to permission. Also, one of the cards included an explicit denial.

c) Thematic-2: "*If a person rides a motorbike, then they must wear a helmet"*. The four cards that were represented were: *"motorbike", "car", "helmet"* and *"cap"*. The rule expresses an obligation -a traffic regulation-. As in the abstract version, the modal verb "*must*" is included.

Two different versions were made for each of the types of booklet. In one of these the abstract version was included at the beginning, followed by the two thematic versions. In the other, the thematic versions were at the beginning, followed by the abstract rule.

Finally, the order of presentation of the two thematic versions for all of the booklets was counterbalanced. This meant that in half of the booklets thematic-1 was followed by thematic-2, and in the others the order was the opposite.

Procedure

Subjects were assigned at random to one of four experimental groups: 1) Available scenario-instructions for verifying or falsifying the rule, 2) Available scenario-violation instructions, 3) Non-available scenario-instructions for verifying or falsifying the rule, and 4) Non-available scenario-violation instructions.

Participants were tested in groups and presented problem booklets containing three Wason's selection tasks, preceded by an instruction page. The instructions were read to the subjects, and then they were asked to read them again to themselves. Questions were solicited from the subjects to ensure that they understood the instructions.

Finally they were allowed to work at their own rhythm, without a time limit.

RESULTS

The analyses were carried out with the data from the 183 subjects, once those who had not completed the task had been eliminated.

A) ***Selection of answers***

In Tables 1, 2 and 3, the distribution of frequencies of the selection of each card is presented, in each experimental condition, as well as the measurements for the logical and matching indices. In turn, Table 4 presents the frequency of selection of individual cards for each condition, in the three experimental tasks.

There are significant differences in the selection of cards with regard to the ***content*** of the rule. The selection of "***p and not-q***" (correct answer): (χ^2 = 18.71; p<.001), is more frequent in the thematic-2 version (traffic regulation). In turn, in the thematic-1 version (law), this selection is even less frequent than in the abstract version. Also, with abstract content (letters and numbers) in the rule, the subjects select the cards "***p and q***" more (χ^2 = 19.39; p<.001). Therefore, in the non-available abstract condition, the frequency of selection of the correct answer increases significantly with regard to the available-abstract condition. However, in the thematic-permission version, with an available scenario, the subjects select the ***"p only***" card significantly more, compared to those subjects who select it in a non-available scenario (χ^2 = 4.84; p<.05).

Also, when the subject has to work with letters and numbers (the abstract version of the task), the ***type of instructions*** given to the subjects (checking vs. violation) do not significantly influence the cards that are selected. In the thematic-permission version, the subjects who receive verification / falsification instructions select the "***p only***" card more

(χ^2 = 15.79; p<.01) and the cards "***p and q***" together (χ^2 = 3.97; p<.05), than those who receive violation instructions. In the thematic-obligation version, subjects who receive checking instructions of the veracity of the rule tend to select the "***p only***" card, (χ^2 = 3.90; p<.05) and "***q only***" card (χ^2 = 5.59; p<.01) more than those subjects who receive violation instructions.

B) ***Logical index and Matching index***

The logical and matching indices were calculated for each of the three tasks. These indices give marks, according to Pollard and Evans (1987), in the case of the matching index, with +1 the *p* or *q* y-1 selection and with -1 the *non-p* or *q* selection. In the logical index, the *p* or *non-q* selection gave a mark of +1, and the *non-p* or *q* selection gave -1. Both indices vary, therefore, between +2 and -2. **Tables 1, 2** and **3** shows these indices for each of the three tasks. ANOVAs 2 x 2 x 2 x 3 (availability x instructions x order x content) were made for each type of index.

Table 1. Mean matching, logical indices[1] and selection patterns, as a function of condition (abstract content).

ABSTRACT CONTENT							
	AVAILABLE			**NOT-AVAILABLE**			TOTAL
Mean Index	**T/F**	**Violation**	Total	**T/F**	**Violation**	Total	
Matching	1,299	0,959	1,129	1,078	0,888	0,983	1,056
Logic	0,192	0,466	0,329	0,441	0,383	0,412	0,371
Selection							
p	5	7		8	5		
p & q	25	18		22	23		
p & not-q*****	4	4		7	6		
p & not-p	3	1		1	1		
p , not-p & q	1	1		-	-		
p , not-p, not-q	-	1		-	-		
p, q , not-q	3	4		1	2		
q	3	-		1	-		
Not-q	1	2		-	-		
Not-p	-	1		2	1		
Not-p & q	2	-		-	-		
Not-p & not-q	-	2		1	5		
q & not-q	-	-		1	-		
Not-p, q & not-q	-	-		-	-		
p, not-p, q, not-q	-	2		1	3		
Void	-	-		1	1		

[1] Indices vary between +2 and -2

***** Correct selection

Table 2. Mean matching, logical indices[1] and selection patterns, as a function of condition (Thematic-Permission content).

THEMATIC-PERMISSION CONTENT							
	AVAILABLE			**NOT-AVAILABLE**			TOTAL
Mean Index	**T/F**	**Violation**	Total	**T/F**	**Violation**	Total	
Matching	0,978	-0,112	0,433	0,130	0,173	0,101	0,2675
Logic	0,000	-0,237	-0,118	0,174	0,339	-0,082	-0,100
Selection							
p	8	-		2	1		
p & q	17	6		7	9		
p & not-q*****	1	4		8	1		
p & not-p	4	2		6	3		
p, q & not-q	3	1		2	1		
p , not-p & q	-	1		-	-		
p, not-p & not-q	-	-		-	-		
q	3	1		2	2		
Not-q	-	1		-	-		
Not-p	1	4		4	4		
Not-p & q	5	6		3	7		
Not-p & not-q	-	8		5	5		
q & not-q	1	2		5	2		
Not-p, q & not-q	-	1		-	-		
p, not-p, q, not-q	4	4		2	10		
Void	-	2		-	2		

[1] Indices vary between +2 and -2

***** Correct selection

Table 3. Mean matching, logical indices[1] and selection patterns, as a function of condition (Thematic-Obligation content).

THEMATIC-OBLIGATION CONTENT							
	AVAILABLE			**NOT-AVAILABLE**			TOTAL
Mean Index	**T/F**	**Violation**	Total	**T/F**	**Violation**	Total	
Matching	1,192	0,712	0,952	0,891	0,722	0,806	0,879
Logic	0,600	0,744	0,672	0,543	0,807	0,675	0,673
Selection							
p	9	3		7	6		
p & q	21	12		14	13		
p & not-q*****	10	11		9	14		
p & not-p	1	3		2	2		
p , not-p & q	-	1		2	-		
p , not-p & not-q	-	1		-	-		
p, q & not-q	3	8		6	5		
q	2	1		3	-		
Not-q	-	1		-	-		
Not-p	-	1		1	1		
Not-p & q	1	-		1	-		
Not-p & not-q	-	-		1	1		
q & not-q	-	-		-	1		
Not-p, q & not-q	-	1		-	-		
p, not-p, q & not-q	-	-		-	4		
Void	-	-		-	-		

[1] Indices vary between +2 and -2

***** Correct selection

Table 4. Frequency of selection of individual cards in each experimental condition.

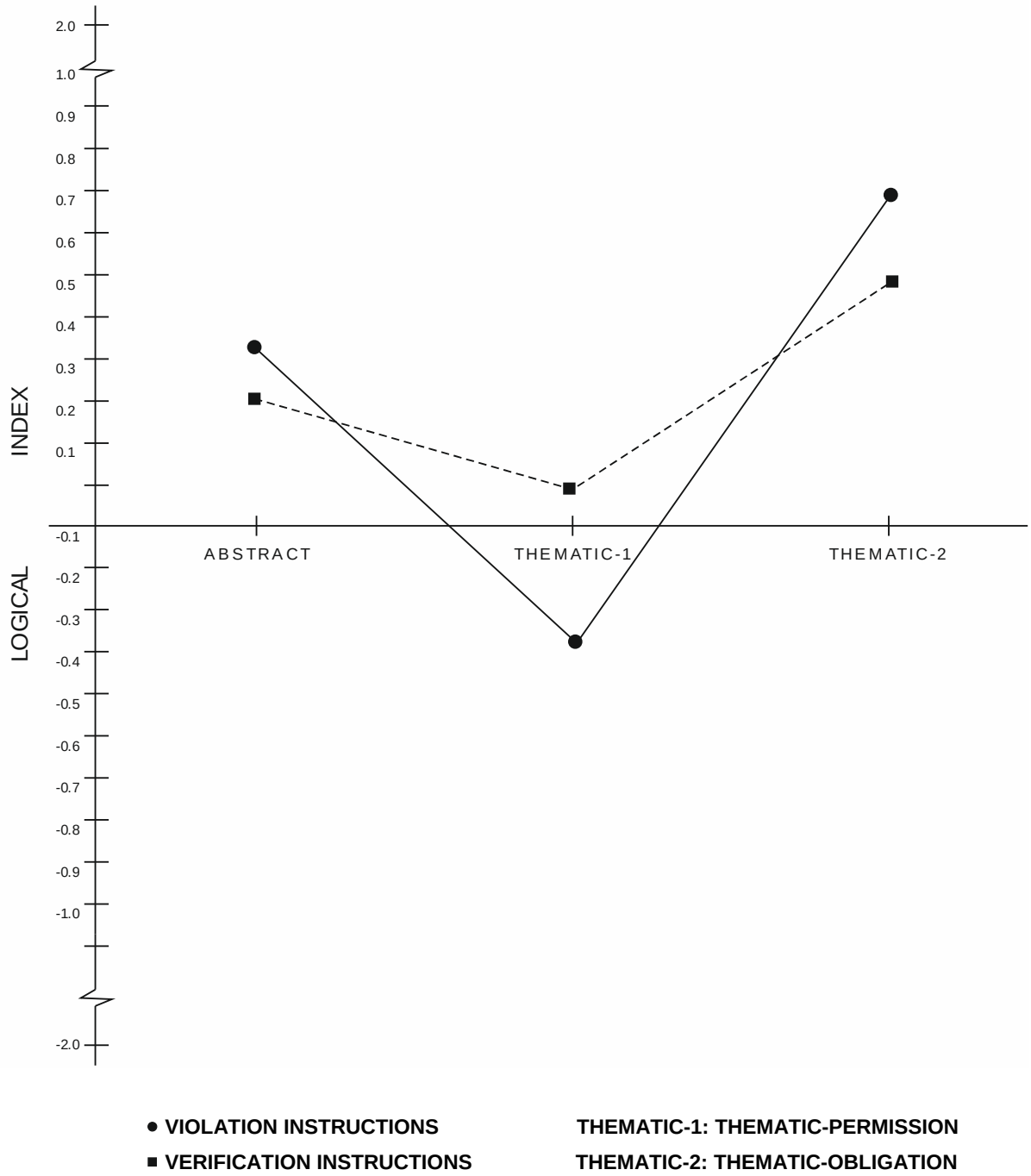
		AVAILABLE		NON-AVAILABLE	
	Cards	**T/F**	**Violation**	**T/F**	**Violation**
ABSTRACT	p	41	38	40	40
	Not-p	6	8	5	10
	q	34	25	26	28
	Not-q	8	15	11	16
THEMATIC PERMISSION	p	37	18	27	25
	Not-p	14	26	20	29
	q	33	22	21	31
	Not-q	9	21	22	19
THEMATIC OBLIGATION	p	44	39	40	44
	Not-p	2	7	7	8
	q	27	23	26	23
	Not-q	13	22	16	25

B.1.) *Logical Index*

For the **logical index**, the principal effects of the **content** were registered ($F(1.72, 300.69)=40.21$; $\varepsilon= .8591$; $p<.0001$). In the Thematic-obligation version (Thematic-2), higher logical indices were obtained (M= .673), followed by the abstract version of the task (M = .368). Finally, the lowest logical indices were registered in the Thematic-permission version (Thematic-1) (M= -.100). Posterior contrasts indicate significant differences in the selection of the correct answer between the thematic-obligation version and the other two $F(1,175) = 49.821$; $p< .0001$, as well as between the abstract and thematic-permission tasks ($F(1,175) = 19.40$; $p < .0001$.

Significant interactive effects have also been registered for **instructions x content** ($F(1.72, 300.69) = 6.40$; $p< .003$). Concretely, as may be seen in **figure 1**, both in the abstract and the thematic-obligation versions, the logical indices are higher in those subjects who receive violation instructions ($M_V = .424$ and $M_V= .775$ respectively), while in the thematic-permission version, higher logical indices were obtained in those subjects who received instructions for checking the rule ($M_{V/F} = .087$), compared to those who receive violation instructions ($M_V = -.288$). However, in this version (thematic-permission), the logical indices are lower than those obtained both in the thematic-obligation version and the abstract version of the task.

Figure 1. Interactive effects of the type of instructions and the type of content on the logical index



B.2.) *Matching Index*

Regarding the **matching index**, significant effects were also registered in the content ($F(1.91, 333.68) = 42.08$; $\varepsilon = .95338$; $p < .0001$). Concretely, the highest matching index was obtained in the abstract version of the task ($M_{ABST} = 1.056$), followed by the thematic-obligation version ($M_{THEM-2} = .879$), with the lowest matching indices being registered when the subjects reasoned about a rule expressing a law ($M_{THEM-1} = .267$).

Similarly, a significant effect was obtained with the **instructions** variable, ($F(1,175) = 9.71$; $p < .002$). Subjects obtaining higher matching indices were those who were given instructions for checking the rule ($M_{V/F} = .928$), compared to those who received violation instruction ($M_V = .557$).

An important interactive effect was also registered for **availability x instructions** ($F(1,175) = 4.88$; $p < .028$). Faced with an available scenario, subjects who had received instructions for checking the rule achieved matching indices that duplicated those obtained by those subjects who, with the same scenario, had received violation indices for the rule ($M_{V/F} = 1.156$ compared to $M_V = .519$). However, when the subjects considered the framework of a non-available scenario, the differences between the averages for the matching indices that were obtained with both types of instructions were reduced significantly, ($M_{V/F} = .699$ compared to $M_V = .594$).

A significant interactive effect was also observed in **order x content** ($F(1.91, 333.68) = 5.27$; $p < .006$; $\varepsilon = .95338$). In the abstract and thematic-obligation versions, the highest matching indices were obtained when the thematic task was carried out firstly, followed by the abstract task ($M = 1.211$ and $M = .933$ respectively), while in the thematic-permission

version, lower matching indices were produced by those subjects who were initially presented with the thematic task (M = .200) compared to those who were firstly presented with the abstract task (M = .419).

DISCUSSION

A) Content Effect

The highest logical indices were registered when the subjects reasoned about a thematic version of the rule whose content expressed a traffic regulation ("*if a person rides a motorbike, then they must wear a helmet").* Worse performance was not registered with the abstract content, but when the subjects carried out a thematic version whose content expressed a law ("*if a person is older than 18 then they have the right to vote)*. Therefore, the thematic content of the rule only appears to improve the subjects' performance in the selection task in a few cases. Whatever the situation, the subjects' reasoning is not independent from thematic factors, as is defended by models of formal rules. Neither are they easily explicable through alternative theoretical suggestions that justify the subjects' performance based on the activation of counterexamples specifically evoked by the subjects from memory (for example, see Griggs & Cox's perspective, 1982; Griggs, 1983, regarding the key elements of memory and analogue reasoning, or Pollard's theory of accessibility, 1982).

The Theory of Pragmatic Schemas defends the fact that subjects reason by applying pragmatic schemas of reasoning, that are activated in contexts that allow them to evoke situations of permission, obligation etcetera. For Cheng and Holyoak (1985, 1989; Cheng and colleagues, 1986; Holyoak and Cheng, 1995), all of the contents that have facilitated a

correct performance of the selection task evoke some kind of schema. When the subjects are reasoning with the abstract version presented in this experiment, they could be activating a pragmatic schema of obligation, elicited from the contextual situation in which the task is developed. The result is an improved performance than that registered in previous investigations with the original abstract version, in which this type of activation did not appear to be possible.

In our experiment, the abstract version we have used is a "*modified version"* of the classic task (Wason, 1966). The fundamental modification is the inclusion of the deontic imperative modal "*must*" in the conditional rule *("if a Wasit card has an A on one side then it must have a 3 on the other*"). In this way the subjects are not reasoning with an arbitrary abstract version but instead, following the terminology used in schema theory, by authors such as Manktelow and Over (1990, 1991, 1992), with an abstract deontic version which expresses a conditional obligation.

Also, the thematic version which we have called "thematic-obligation" may be included in the same schema of conditional obligation as the previous abstract version: "*if a person rides a motorbike then they must wear a helmet";* generally, "*if the precondition is satisfied, then the action must be carried out".*

Finally, the thematic version called "thematic-permission" presented a schema that we could refer to as a "schema of conditional permission": "*if a person is more than 18 years old, then they have the right to vote", ("if the precondition is satisfied, then the action may be carried out").*

Thus, based on the theory of pragmatic schemas, and particularly on Holyoak and Cheng's studies (1995), the three versions which are developed could be assimilated, respectively, to the O_1 rule of the

obligation schema (abstract deontic version and thematic-obligation version) and to the P_3 rule of the permission schema (thematic-permission version).

If we analyse the frequency of the selection of cards in the three versions of the task, then we observe that some of our results are consistent with those of Holyoak and Cheng (1995), and may be explained within the framework of the theory of pragmatic schemas. However, we also obtained some results that are not easily explicable by way of the basic principles of schema theory.

More specifically, the authors quoted found a higher percentage of subjects who selected the "*p*" and "*not-q*" cards individually and "*p and not-q*" together, when the rule used could be assimilated with the O_1 rule belonging to the conditional obligation schema. Similarly, these selections were less frequent when the rule corresponded to P_3 in the conditional permission schema. In this rule these authors, in keeping with their predictions, registered a higher percentage of selections of the cards "*not p", "q*" on its own and *"not p and q*" together.

If we look at **Tables 1, 2** and **3**, where we offer the frequency of selection of the cards relative to the content of the task, then we can see that in this case our results follow on from those obtained by Holyoak and Cheng (1995). In the version of the task that conforms to the P_3 rule, the "thematic-permission" version, *the "not p", "q"* and *"not p and q"* cards are more frequent than in the two versions that conform to the O_1 rule of conditional obligation. Effectively, in the thematic-permission version, these cards were selected by 13, 8 and 21 subjects respectively. However, the *"not p"* card on its own was selected by 4 subjects in the deontic abstract version and by 3 subjects in the thematic-obligation version; the

"q" card was chosen by 4 subjects in the first version and 6 in the second. Finally, the *"not p and q"* cards were selected by 2 subjects both in the deontic abstract version and the thematic-obligation version.

Therefore, if we focus on the selection of *"p and not q"* cards, which make up the logically correct answer, our results are in line with the predictions of the theory of pragmatic schemas and coincide with those obtained by Holyoak and Cheng (1995). Both in the abstract and thematic-obligation versions, both of which conform to the O_1 rule, 21 and 44 correct selections were obtained respectively, compared to the 14 which were registered in the version corresponding to the P_3 rule of the permissive schema. In effect, *"if a stated rule is matched to Rule P1 of the permission schema or to Rule O1 of the obligation schema, then the so-called "logical" selection of p and not-q will indeed be facilitated. But precisely the opposite selection pattern will be encouraged if the stated rule is instead mapped on to Rule P3 of the permission schema"*. (Holyoak and Cheng, 1995, p. 85)

However, it is difficult to explain the high matching indices which were registered in the deontic abstract version, which conforms to the same rule as the thematic-obligation version. Specifically, *"the theory predicts that performance on the selection task will be facilitated (i.e. be in accord with standard logic) when the stated rule has content that evokes a schema, and the correspondence between the stated rule and the schema rules is such that the latter map on to rules of standard logic"* (Holyoak and Cheng, 1995, p. 69). Furthermore, the theory of pragmatic schemas does not offer any solution for the matching bias, nor is any type of prediction carried out regarding 'selective attention' that the subjects realise with the "*p and q"* cards, which, as we have previously shown, determine the matching

answer.

In our opinion, when the subjects reason about the phrase *"if a person is older then 18, then they have the right to vote*", then they *know* that in their empirical world "if a person has the right to vote they need to be at least 18 years old". On the contrary, when they reason about the rule "*if a person rides a motorbike then they must wear a helmet*", then the development of a biconditional interpretation by the subjects diminishes substantially (only 4 subjects selected all of the cards). In this case, the subjects *know* that "*if a person rides a motorbike then necessarily he must wear a helmet"*, and similarly they also know different situations in daily life where "a person can wear a helmet without this **necessarily** implying that he must ride a motorbike". In this case, we observed a reduction of biconditional interpretations, with conditional interpretation being more frequent, and from which the correct selection ("*p and not q*") was made by 44 subjects.

We definitively coincide with Holyoak and Cheng in showing that it is the activation of pragmatic types of strategies, and not logical mechanisms, which appears to be responsible for way the subjects carry out the selection task. However, perhaps as proposed by Evans and Clibbens (1995), the proposal of the theory of schemas contains production rules which *"seems to us to be over-elaborate, and unnecessary to account for the data"* (p. 320). Generally, in keeping with these authors, and from our results, we would question if the theory of pragmatic schemas or the theory of social contract may give us direct evidence of the process of reasoning, being based upon the systematic application of production rules (and/or rules of social contract).

B) The importance of the deontic content

Manktelow and Over (1991) particularly underlined the influence of deontic reasoning in the subjects' performance in the selection task. For these authors, the theory of pragmatic reasoning schemas does not allow deontic reasoning to be explained as these schemas contain deontic terms such as "must" and "may", that have not been analysed, in principle, by this theory.

The authors put forward an explanation of the subjects' performance in Wason's task, based on the elaboration of mental models, while putting particular emphasis on two fundamental questions: the influence at semantic level of the inclusion of deontic terms in the rule, and the influence of the concrete perspective of the subject who is reasoning. According to Manktelow and Over (1991), subjects at times interpret some conditionals as deontic conditionals, and consequently, when they solve the task, they check if the rule has been broken. This strategy, which is precisely what guides the subject towards a correct reasoning, would allow the superiority of the percentage of "*p and not q*" selections registered to be explained in our investigation, in the two deontic versions (abstract and thematic-obligation), compared to the thematic-permission version, that could be interpreted as an indicative rule. In turn, the higher level of correct selections obtained in the deontic abstract version, compared with previous results from the original abstract version, could be due to, according to the authors, that *"conditionals in deontic tasks do not have the same logical form as ones in "symbolic", "abstract", or "indicative" tasks".* (Manktelow and Over, 1995, p. 93).

However, depending on the subjects' point of view a deontic rule, these may select the *"p and not q", "not p and q"* or *the four cards*. This

proposal does neither predicts nor explains the high frequency of selection that was registered with the *"p and q"* cards in the deontic abstract task. In reality, it is complicated for us to try and analyse how we could incorporate the concept of "usefulness" (or preference of the people solving the tasks), to be able to explain the results we have obtained. This may be due to, as Byrne and Johnson-Laird (1990) observed, that it is the particular way of manipulating the instructions performed by the authors which allows the subjects' answers to be justified with regard to their subjective probability. This allows for the prediction of the type of concrete alternatives upon which the subjects will focus their attention. For Byrne and Johnson-Laird (1990), this is an external and unnecessary manipulation to explain the process of reasoning itself.

Byrne and Johnson-Laird (1990) coincide with Manktelow and Over in two important questions which explain the subjects' performance in the selection task. On one hand, the type of strategies used by the subjects to reason are mental models; on the other, they point out the importance of the modal verb incorporated in the wording. Effectively, *"the modal verb alerts people to the possibility of alternative outcomes"* (Byrne & Johnson-Laird, 1990. p. 142). However, according to these authors this does not imply that it is necessary to develop a deontic context to observe facilitation in the selection task. In fact, Johnson-Laird and Byrne proposed that "*any manipulation that draws attention to counter-examples should improve peformance even if the materials are not deontic*" (1991, pp. 80-81). So, for example the manipulation of the *instructions* may lead the subjects to focus their attention on one series of models more than on others; the manipulation of the *content* may make those examples which violate the rule more outstanding, and elicit a framework where violations may be

more evident.

According to the authors, precisely when the subjects reason about a simple indicative conditional, such as the thematic-permission version which we used*: "if a person is 18 years old then they have the right to vote*", they normally tend to represent it at least by way of an explicit model (that satisfies the rule's antecedent and consequent), and an implicit model which may or may not occur (meaning that it includes the possibility that the antecedent is not fulfilled). However, when the subjects reason about deontic enunciatives (e.g. "*if a person rides a motorbike then they must wear a helmet*") then they tend to reason by elaborating a unique mental model representing what is allowable.

According to this proposal, and from the basic principles of the theory of mental models, the highest logical indices registered in the thematic-obligation version could be explained by way of the lower number of mental models which the subjects need to elaborate, which in turn causes less strain on operative memory, and consequently brings about more correct reasoning.

Also, in the thematic-permission version, the high frequency of selection of "*not p and q*" is outstanding (21 subjects selected this answer compared to 2 who chose it in the other 2 versions). A possible explanation suggested by Johnson-Laird and Byrne (1992) about the frequency of selection of "*not p and q*" is that *"when the modal auxiliary, "**may**", occurs in the consequent of a conditional of the form: If p occurs then q **may** occur then, given a plausible everyday content, reasoners are likely to construct a fully explicit set of models ... and to select the not p and the q cards to test the truth of the conditional"* (p. 180: our bold text). This same argument would be applied to deontic conditionals, although in many cases general

knowledge may lead to the development of biconditional interpretations. Effectively, in the thematic-permission version *("if a person is older than 18 then they have the right to vote*"), the subjects' own knowledge could be determining the high frequency of selection of the 4 cards (20 subjects used this type of selection compared to 6 and 4 who did it in the deontic and thematic obligation version, respectively). Specifically, the subject know that for a person to vote it is **necessary** to be 18 or older. This empirical knowledge could be allowing for the development of a symmetrical interpretation of the relation, and, definitively, increasing the selection of "*p, not p, q and not q*".

Similarly, the high matching indices registered in the abstract version which we used could be explained from Johnson-Laird and Byrne's (1991, 1992) perspective, where the majority of the subjects only represent explicitly the values mentioned in the rule ("p *and q*" in our case). In turn, depending on its internal representation, the subjects will select "*p"* or "*p and q*". For example, if they interpret the rule "*if a Wasit card has an A on one side then it must have a 3 on the other"* as a conditional, they will tend to only select the "p" card (A), as this would be the only card explicitly represented that refers to the truth of the rule. The probability of the subjects carrying out the correct selection increases when they develop models of the conditional and comprehend the necessity of considering the "*not q*" card to evaluate the rule.

Also, Evans (1984, 1989) in his framework of the "theory of the heuristic-analytic process", proposed that the subjects' answers are based upon a judgement of *relevance*. According to the author, when the subjects reason about the task, they firstly develop a phase of heuristic processing, where they selectively look at (or, in Johnson-Laird's terminology, focus

their attention on) certain cards that they consider relevant with regard to criteria of a linguistic and/or pragmatic nature. Next they develop a second phase of analytic processing, or the real phase of reasoning, that according to the author does not always take place. In fact, Evans (1991) suggested that the theory of mental models could lay the foundations for his analytical study of reasoning, that was, in principle, of a non-specific character.

Specifically, Evans proposed that when subjects reason about the abstract version of the task, the poorness of performance observed depends on two factors: the selective decodification of the information of the problem from attentional factors, and the absence of satisfactory analytical processing. This would explain from his perspective the high indices of matching that were registered in the abstract version of the task. Subjects would focus their attention on the values mentioned in the rule (A and 3 in our case). The values give the linguistic topic of the pronouncement, therefore making it more probable that they are catalogued as relevant and consequently are more frequently selected.

Although the highest matching indices were registered in the abstract version of the task, we also observed relatively high matching indices in the thematic-obligation version, particularly when compared to the other thematic version that was used. As Evans and colleagues (1993) proposed, the decrease of the matching indices frequently observed when subjects reason about thematic versions, could be related to the activation of pragmatic, more than linguistic, clues, that define the relevance of the cards, or to the development of the posterior phase of analytical reasoning. Our results show that the presence of a thematic content does not always reduce or eliminate matching answers.

However, and perhaps because the relation expressed in the thematic-permissive version is less restrictive -or in Margolis' (1987) terms, the scenario is more ambiguous-, the subjects also show a greater tendency to develop a reversible interpretation, focusing their attention on all the cards. In this sense, the selection pattern "*p, not p, q, not q*" is notably higher than in the other two versions.

C) Effect of the Instructions

In this experiment, no principal effect was registered by the instructions on the logical index, although they did so on the matching index. There also exists a significant interaction between instructions and content upon the logical index.

In our case, the **significant interactive effect between instructions and content, registered in the logical index**, appears particularly interesting to us. Previous investigations (Griggs, 1984; Chrostowski and Griggs, 1985, or Yachanin, 1986), also showed this interactive effect between instructions and the content of the problem. Specifically, we observed that the V/F instructions facilitated correct performance in the thematic-permission version, but not in either the thematic-obligation or the abstract versions. In these two **deontic versions, higher logical indices were registered in the group of subjects who received violation instructions** for the rule. Likewise, Platt and Griggs (1995) pointed out that perhaps *"modals in combination with the violation instructions may lead subjects to interpret the rules as deontic"* (p. 68).

Platt and Griggs (1995) also registered a high percentage of correct selections (around 80%) in the abstract version of the task in a group of

subjects who had received violation instructions, when they were presented with an explained rule and they were asked for the reasons for their answers. These authors presented an interpretation of their results in terms of the theory of mental models and of Evan's heuristic-analytic theory. In effect, they suggest that as the selection of cards is normally determined by heuristic processes, then certain manipulations may induce in the subjects the development of analytical processing, thus improving logical performance. Violation instructions appear to increase the possibility of developing a falsifying strategy during the analytical processing of the task, thus increasing the facilitating effect. When asked for the selection of cards which violate the rule, this may cause the subjects to *"put more enphasis on the not-q card and may make the subject more likely to encode it as relevant"* (Platt and Griggs, 1995, p. 57). In terms of the theory of mental models, the subjects would more easily develop the explicit representation of the impossible (in our case, A and 7).

The results of our experiment support Platt and Grigg's interpretation. This result has allowed us to point out three themes which we consider important. Firstly, violation instructions do not always improve the subjects' logical performance. Secondly, this possible facilitating effect with violation instructions does not appear to depend, at least exclusively, upon the thematic nature of the content of the rule. Effectively, we did register better results with violation instructions in a thematic version (thematic-obligation); however, this result was not maintained in the other thematic version used (thematic-permission).

Definitively, the presence of a thematic content does not appear to be a necessary, or at least sufficient, condition to observe facilitation with violation instructions. In fact, we registered better performance with

violation instructions in the abstract version than in the thematic version (thematic-permission), where the subjects received the same type of instructions. Therefore, there appear to exist other variables that could be modulating this influence.

Thirdly, and in agreement with Platt and Griggs' (1995) results, we observed that the subjects' performance in the abstract version of the task improved in the group who had received violation instructions, compared to instructions for checking the rule. These results differ from those observed by other authors (such as Griggs, 1984; Chrostowski and Griggs, 1985; Valentine, 1985, or Yachanin, 1986, among others), that did not register facilitation in the abstract version of the task with violation instructions.

In our study, the instructions and the scenario in which the tasks took place were very similar to those used by Griggs (1984) in an investigation where he manipulated the role of the instructions (verification/falsification vs. violation), and of the content of the task (abstract vs. thematic). In Griggs' study, the subjects' role was of an inspector on duty. In our case it was a lawyer or clerk, depending on the level of accessibility of the scenario that was presented. The abstract version used included the same deontic conditional rule used by the author. In turn, the thematic version he used was that which had been previously used by Griggs and Cox (1982) regarding the age when one should be allowed to drink alcoholic substances. However, as we have pointed out, our results are different from those obtained by the author.

As Platt and Griggs (1993) suggested, it is possible that the V/F instructions enable a tendency to elicit verifying strategies and so to check the values that are in accordance with the rule. On the contrary, the

violation instructions can increase the tendency to elicit falsifying strategies that lead them to analyse the values that violate the rule. In terms of the theory of mental models, the subjects who receive violation instructions for the rule, should mentally recognise the "non- permissibility" that "*p*" (A) occurs with "*not q*" (7). These instructions could also determine, in terms of the theory of heuristic-analytic and the theory of mental models, the relevance of a counterexample via heuristic processes and cause its explicit mental representation.

The tendency to develop non-logical matching strategies could perhaps be related, according to Yachanin and Tweney (1982), to the type of task that the subjects are asked to carry out. When they are asked to analyse if a rule has been violated, this is taken to be true, and they are asked, reasoning from this point, to check if it has been violated. However, when subjects have to check the truth or falsity of the rule, they are reasoning *about* the rule and analysing its status of truth, and so have to study two hypotheses instead of one. Consequently, as shown by Tweney and Doherty (1983), the cognitive load is greater and so the complexity of the task would increase. This could be one of the reasons that cause subjects to develop strategies of a "cognitive short-circuit" (such as the matching strategy), thus reducing the number of hypothesis to be processed. Given that the cognitive load would be lower in the violation version, in this case the tendency to adopt this type of strategy would be reduced and would lead the subjects to play a "detective game" where they would look for counterexamples to the rule (Van Duyne, 1974). This perspective would allow the higher matching indices registered with V/F instructions to be justified, but not the results, that have already been discussed, obtained on the instruction paper in the logical index.

In a previous investigation (Valiña, Seoane, Ferraces and Martín, 1995), whose principal objective was to study the individual differences in Wason's selection task, two types of content were used: thematic (similar to our thematic-obligation version) vs. abstract (letters and numbers), and two types of instructions: violation and checking of the rule, similar to those used by Yachanin (1986). The scenario where the task took place was that which had previously been used by Chrostowski and Griggs (1985) and Yachanin (1986). In general, the results of this present experiment are in line with those registered by the authors of the investigation referred to. Significant differences were obtained in both studies in the matching index with regard to the type of content, with the highest indices being registered in the formal version of the task. Significant effects of the type of instructions were also observed in both studies in the matching index; precisely, those subjects who received checking instructions for the rule registered matching indices superior to those who had to see in which cases a violation had been committed.

In the logical index, significant effects were observed in the content: the subjects who carried out the abstract version of the task registered lower logical indices compared to those who had received a concrete content. In this study we also obtained significant principal effects of the task content. When the subjects reasoned about the abstract version, a worse logical performance was registered than when they reasoned about the thematic-obligation version, whose content, as previously shown, was similar to that used by the authors.

However, Valiña and cols. (1995) registered significantly higher logical indices with violation instructions. In this experiment the design used, where the type of instructions were manipulated between-group, and

the content of the rule within-group, has allowed us to analyse the subjects' performance in the three versions of the task, using, in both the two thematic versions and the abstract version, violation instructions and instructions for checking the rule. The results obtained do not allow us to affirm that the cause of the thematic facilitating effect was the use of violation instructions. In fact, as already commented, we did not register this effect in the thematic-permission version.

D) Availability Effect

The logical performance of the subjects did not improve significantly with regard to the level of availability of the context in which it took place.

However, a significant interaction was registered between the availability of the scenario and the instructions which the subjects received. Those who reasoned about accessible contexts and received instructions for checking the rule showed a greater tendency for matching than those subjects who, reasoning in the same context, received violation instructions. In turn, in the group of subjects who reasoned about non-accessible contexts, higher matching indices were registered with those who received violation instructions.

Therefore, the availability of the scenario influenced the group of subjects who received checking instructions for the rule, determining the relevance of the cards that were mentioned in it (*p* and *q*). However, among the subjects who reasoned in a non-accessible context, the *"p* and *q*" cards were judged as relevant more often by those who had received violation instructions.

Evans (1995) observed that subjects committed a matching bias when the task took place without a scenario, and that this bias disappeared

in another group of subjects who had been presented the task within a scenario. In our case, we only registered significant differences in the matching index with regard to availability of scenario in the "thematic-permission" version. However, the influence of this variable was in turn modulated by the type of instructions that were received. In the same way, the fact that no significant principal effects were registered in the subjects' performance with regard to the scenario may be due, as Evans indicated, to the fact that availability is not a *sufficient* condition to improve reasoning.

It is possible that the fact that significantly higher logical indices were not registered in an available scenario compared to a non-available one is due, as Pollard and Gubbins (1982) suggested, to the rule not being perceived as an integral part of the scenario, with the possible effect thus being destroyed. It is also possible that the context in which the task develops increases the subjects' tendency to activate their own conceptual system and to apply actions which take place in real life, where the subjects appear to develop a more pragmatic than logical type of reasoning.

In reality, the absence of significant differences in logical performance between an accessible scenario and a non-accessible one is, up to a certain point, expected, if we bear in mind that the manipulation carried out in this experiment of the accessibility variable is reduced to the introduction into the task of different types of professions, that varied in a gradient of accessibility. It is certainly possible that this factor does not significantly modulate the subjects' performance as it does not allow for the elaboration of *"mental framework that is actively transformed, with the intention of deriving its factual and plausible consequences from the "mental simulation" mode"* (Valiña and De Vega, 1988, p. 58).

CONCLUSIONS

As Johnson-Laird & Byrne has pointed out, "*the content of the premises can exert a profound effect on the conclusions that people draw, and so a uniform procedure for extracting logical form and applying formal rules to it may not account for all aspects of performance*" (1991, p. 35). The results of our experiment allow us to move away from those formal perspectives which characterise human reasoning as a syntactic type of reasoning, based on the activation of logical rules of an abstract nature and of a universal character.

Some of the results obtained may be explained within the framework of the theory of pragmatic reasoning schemas. Others, such as the presence of matching bias in the subjects' selections, are difficult to explain within this theoretical framework. On the contrary, Evans' (1984; 1989) theory of heuristic-analytic processes and Johnson-Laird's theory of mental models (1983); Johnson-Laird and Byrne (1991) develop a detailed explanation about the causes which cause subjects to commit matching bias, and in general about the principal phenomena observed in the subjects' performance in the selection task. Therefore, both theories appear to be the most attractive candidates for explaining the results we obtained in this experiment.

Clearly, the subjects, when reasoning, appear to be elaborating mental representations both from the information contained in the premises and from their knowledge of the world. In turn, it is possible that they may develop preconscious strategies that lead them to focus their attention on certain cards which, as we observed, are not necessarily the "correct" ones. This selective attention or this judgement of relevance towards certain selections, appears to be modulated by the type of variables that are

manipulated. These could be outlining what has to be *explicitly represented*, and / or what must be submitted to a later phase of *analytical processing*. In this respect, as the authors of the theory of mental models suggested, any manipulation which leads to the development of the models of the conditional with explicit representations of the false consequent, will tend to produce an insight about the task. However, as Love and Kessler (1995) suggested, the obvious question is what type of manipulation or manipulations may reach this objective.

Within the framework of mental models theory, Johnson-Laird and Byrne (1992); Byrne and Johnson-Laird (1992) offer a detailed explanation of the differences in the subjects' performance when they reason about indicative conditional pronouncements that are "**probable**", compared to deontic conditionals which present a character of "**necessity**". According to the authors, the number of mental models which the subjects need to elaborate to be able to generate the conclusion, is less in the case of deontic conditionals, and in consequence, the reasoning will be better. In effect, we registered a more correct logical achievement when the subjects reasoned about deontic conditional rules. The question is: How may our results be generalised to other types of tasks closer to the subjects' daily lives?

The results we obtained in this experiment only allow us to establish conclusions within the framework of a metainference task, like the selection task. However, as Johnson-Laird proposed (1995), the phenomena observed in the subjects' performance in Wason's task have little psychological justification outside of the selection task.

Our interest in studying the importance of knowledge in the subjects' daily reasoning, with tasks of conditional inference, as well as going into the differences in the subjects' performance with conditional tasks

expressing relations of need and possibility, have led us propose another experiment. In this study (Valiña, Seoane, Ferraces and Martín, 1996), the subjects were presented with conditional arguments, of the four types of rules of propositional logic, where the distinct probability of empirical occurrence of the relation expressed between antecedent and consequent was manipulated, in agreement with previous investigations (Valiña and colleagues, 1992a and b). The results of this experiment confirmed our predictions, as the subjects' reasoning was influenced both by the type of logical rule and by the probability of empirical occurrence of the antecedent-consequent relation.

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